

RCA MONOLITHIC FERRITE MEMORY MODULE



MF2100

TENTATIVE DATA

RCA MF2100 Monolithic Ferrite Memory Module is a word-address, two-intersection-per-bit 64-word x 64 bit magnetic-memory device. It is intended for use in memory systems employing READ/REGENERATE cycle times of 0.2 to 0.8 microsecond.

This Module consists of a plane 4.5" x 3.75" x .22" thick, containing two monolithic storage arrays, an integrated silicon-diode selection matrix, and all internal interconnections, as well as terminals for external circuit connectors having standard 50-mil center-to-center contacts.

The storage arrays of the MF2100 are solid monolithic ferrite wafers approximately 1 inch square and 5/1000 inch thick. Each wafer contains 4096 "virtual cores" with an effective diameter of only 5 mils each. The extremely small size of these "virtual cores" permits the MF2100 to provide a full READ/DELAY/WRITE cycle time as short as 200 nanoseconds and output voltages equal to those of conventional core arrays, at driving currents substantially less than those required by present small-core, coincident-current memories.

The unique design of the monolithic ferrite wafers eliminates the need for core wiring and permits batch fabrication of the memory arrays. The "two-intersection-per-bit" flux-switching technique provides bipolar output voltages and eliminates noise due to capacitance coupling between windings.

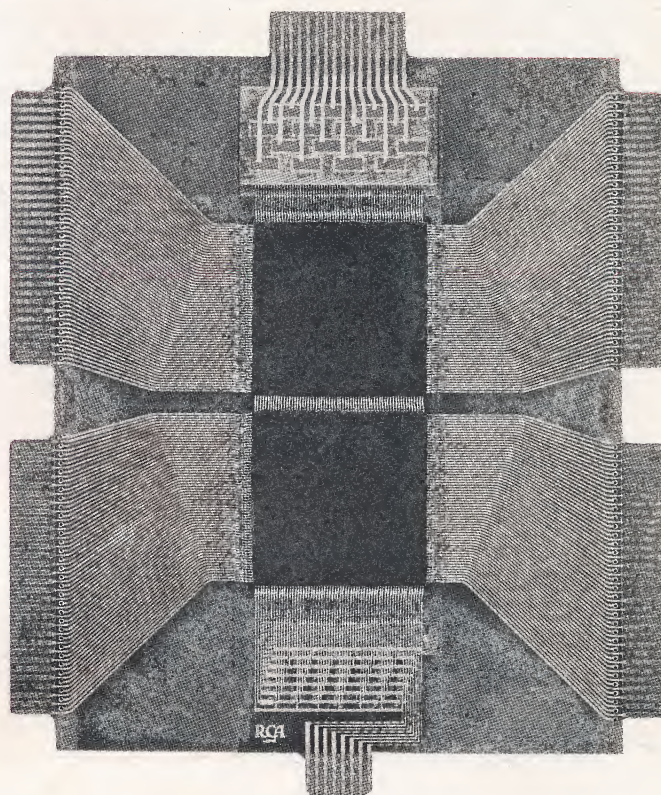


Fig.1 - RCA-MF2100 shown above contains the basic module 4-1/2"x 1.2" complete with integrated diode matrix and 2 wafers.

FEATURES

- High switching speed: $t_s = 35$ nanoseconds typical
- High output voltages: dV_{O-} or $dV_{I+} = 30$ to 45 mv typical
- Bipolar output voltages
- Low driving currents: $I_W = 100$ to 150 ma
 $I_R = 400$ ma $I_D = 30$ ma
- Complete with interconnected integrated silicon-diode selection matrix
- Small Size (Including external circuit terminals) — 4.5" x 3.75" x .22" thick

Driving Current Pulse Characteristics									Typical Performance Characteristics at 25° C (Sense-Winding Terminating Impedance = 150 ohms)		
Read			Write			Digit			dV_{O-} or dV_{I+}	t_s of dV_{O-} or dV_{I+} (10% points)	Read Driving Voltage
I_R	t_r & t_f	t_d (50% points)	I_W	t_r & t_f	t_d (50% points)	I_D	t_r & t_f	t_d (50% points)			
ma	nsec	nsec	ma	nsec	nsec	ma	nsec	nsec	mv	nsec	mv/bit
400	45	110	100	45	120	30	45	200	35	60	250
400	30	80	120	30	100	30	30	200	45	35	300
400	30	60	150	30	30	30	30	100	30	35	320

The type number and tentative data are subject to change. No obligations are assumed for notice of change or future manufacture of the product unless otherwise arranged.

Operating Mode

The MF2100 monolithic ferrite memory module utilizes the word-address, two intersections-per-bit mode of operation. Each module contains 64 word windings and 128 bit windings which are required to provide a total storage capacity of 64 words 64 bits per word, and 128 silicon selection diodes arranged and interconnected to form an 8 x 8 selection matrix.

Figure 2 shows the technique of magnetic flux switching at one crossover point by application of word

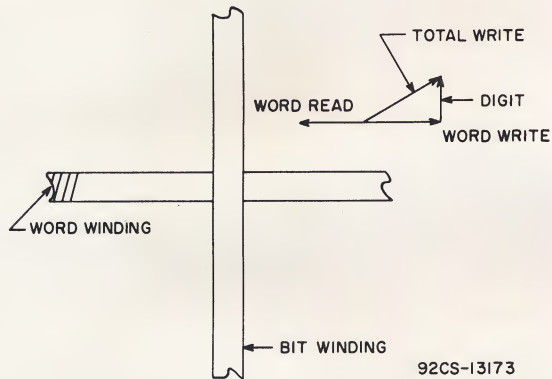


Fig.2 - Simplified analysis of flux switching by coincident word and digit currents at one crossover point.

and digit pulses. When drive pulses are applied only to the word winding no change of flux occurs around the bit winding, and, consequently, no signal is magnetically coupled from the word winding to the bit winding. When the word and digit currents are applied in coincidence,

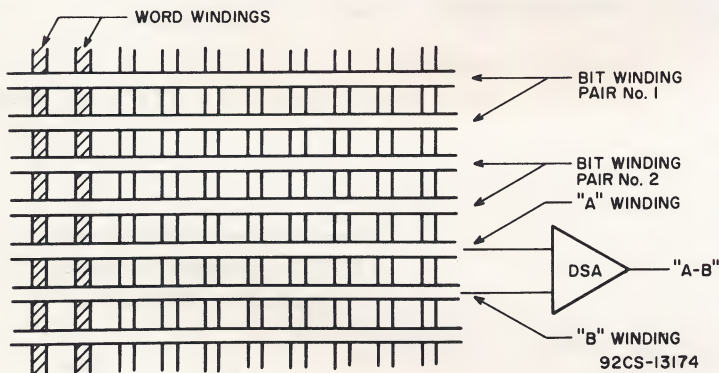


Fig.3 - Simplified schematic showing laminar winding arrangement.

flux is switched about the crossover to a flux state which is in the plane normal to the total write vector as shown in Fig.2. When a read pulse, opposite in polarity to the write pulse is applied to the word winding, the flux coupled to the bit winding by the previous

application of coincident word write and digit current pulses is eliminated, and a magnetically coupled signal voltage appears on the bit winding. The polarity of this signal voltage depends only on the polarity of the digit current.

Figure 3 shows the "two-crossover-per-bit" storage technique. Each pair of bit windings has its own set of digit drivers and a sense amplifier. For the bits of the addressed word which are to store "ones", a positive digit current is applied to bit winding "A" and a negative digit current to bit winding "B". For the bits which are to store "zeros", a positive digit current is applied to bit winding "B", and a negative digit current to bit winding "A". When the same word is next addressed with a word-read pulse (opposite in polarity to the word-write pulse) the "A" lines of bits storing "ones" and the "B" lines of bits storing "zeros" have negative output voltages. The "B" lines of bits storing "ones" and the "A" lines of bits storing "zeros" have positive output voltages. Thus, if the difference sense amplifiers yield A minus B, "one" output signals from the sense amplifiers are negative and "zero" output signals are positive. Note that the total signal output of the sense amplifier is proportional to the sum of the absolute values of signals magnetically coupled at the contributing crossover points. Capacitance-coupled noise is cancelled.

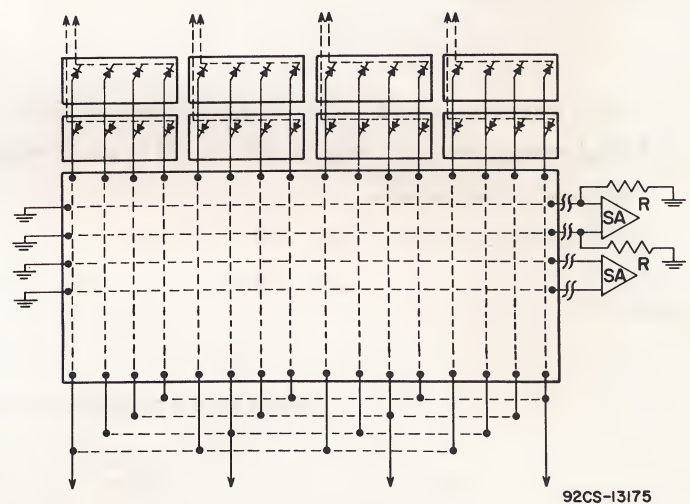
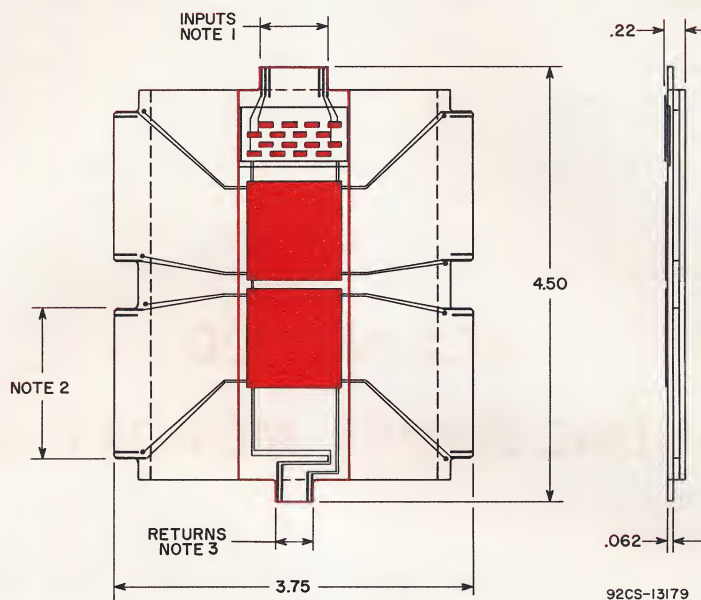


Fig.4 - Drive and sense connection arrangement.

Figure 4 shows a portion of the electrical schematic of the MF2100 module. All connections to the external circuits are brought out to printed circuit landings on 0.050" centers (see Figure 1 for the mechanical configuration).

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

- Note 1:** 16 single-sided connections on 0.050 "centers.
Note 2: 32 double-sided connections on 0.050 "centers.
Note 3: 8 single-sided connections on 0.050 "centers.

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RCA-MF2100

MONOLITHIC FERRITE MEMORY MODULE

**Word-Address, Two-Intersection-Per-Bit, 64-Word x 64-Bit
Magnetic-Memory Device**

For additional information on the MF2100 and other RCA Memory Products, please contact RCA Memory Products Department, 64 "A" Street, Needham Heights, Mass., 02194



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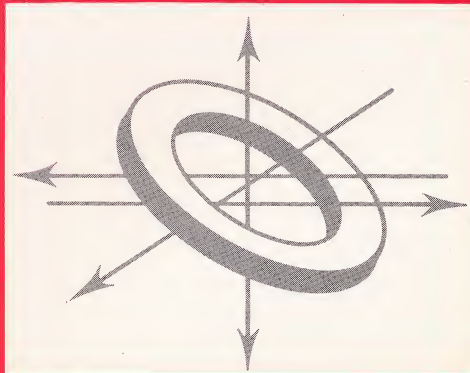
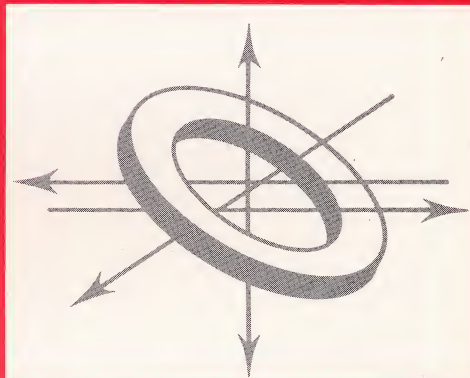
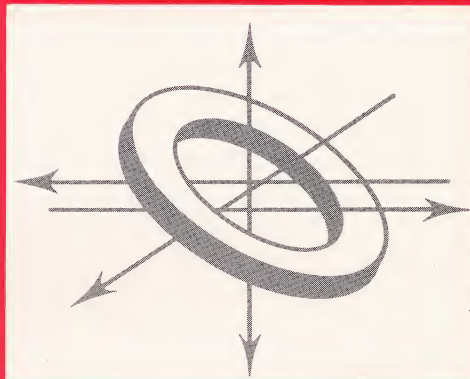
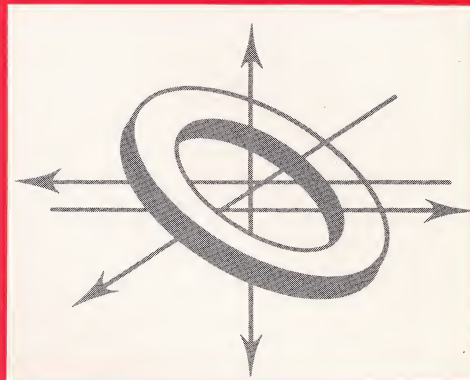
RCA

MEMORY PRODUCTS GUIDE

- CORES
 - TRANSFLUXORS
 - PLANES
 - STACKS
 - SYSTEMS
- AND
- MONOLITHIC FERRITE MEMORIES



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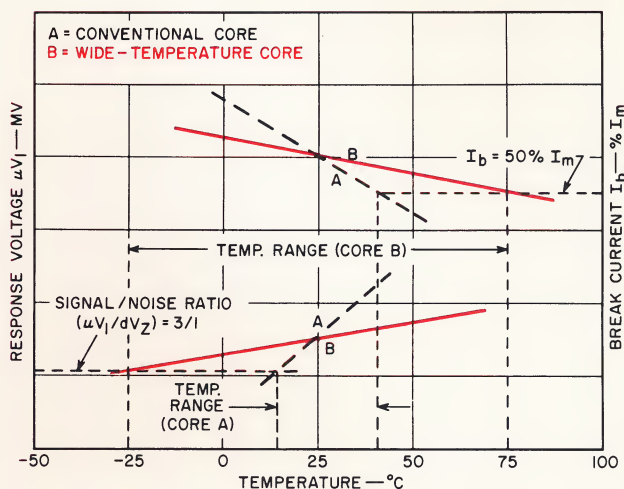
RCA MEMORY PRODUCTS

RCA FERRITE MEMORY CORES

RCA Ferrite Memory Cores include Wide-Temperature Range Types and Conventional Types for Coincident-Current, Word-Address, and Impulse-Switching (Linear-Select) Operation.

Wide-Temperature Range Types permit systems operation over any 100° C interval from -55° C to +125° C without the need for current compensation or temperature controls.

- System Cycle Times — from less than 1 μ sec to 8 μ sec
- Switching Speeds — from 0.18 to 2.4 μ sec
- Low Driving Current Requirements



92CS-12679

Fig.1 - Comparison of temperature effects on break current and "undisturbed 1" response voltage of a conventional ferrite core and a wide-temperature-range ferrite core.

COINCIDENT-CURRENT TYPES

System Cycle Time	Recommended RCA Type		Dimensions		Recommended Driving Current Pulses				Typical Performance Characteristics at 25° C					
	Conventional	Wide Temperature Range	Size OD/ID	Outline Page 8	Full Read or Write Current	Partial Write Current	Rise Time	Duration	"Disturbed-1" Response (Output) Voltage	"Undisturbed-1" Response (Output) Voltage	"Disturbed-0" Response (Output) Voltage	dV ₁ Peaking Time	uV ₁ Peaking Time	Switching Time for dV ₁ & uV ₁
					I_m	I_{pw}	t_r	t_d	dV ₁	uV ₁	dV ₂	t_p	t_p	t_s
μ sec			mils		ma	ma	μ sec	μ sec	mv	mv	mv	μ sec	μ sec	μ sec
<1		0181M5	20/12	A	875	437.5	0.05	0.2	35	—	5	0.10	—	0.18
1-2		0178M5	20/12	A	820	410	0.05	0.25	35	—	5	0.10	—	0.18
		0187M5	20/12	A	820	410	0.05	0.25	35	—	5	0.11	—	0.22
		0175M5	23/15	B	700	350	0.05	0.3	40	—	5	0.13	—	0.25
		0183M5	30/18	C	550	275	0.1	0.5	55	—	7	0.21	—	0.41
		0172M5	30/18	C	700	350	0.1	0.4	60	—	5	0.18	—	0.36
2-4		270M1	30/18	C	800	400	0.1	0.5	65	—	6	0.21	—	0.41
		0173M5	30/18	C	450	225	0.2	0.8	—	50	4	—	0.36	0.6
4-6		0167M5	30/18	C	625	312.5	0.2	0.8	50	—	4	—	0.36	0.58
		232M1	50/30	D	480	240	0.2	1.5	—	80	10	—	0.45	0.95
6-8		264M1	50/30	D	630	315	0.2	1.5	—	80	12	—	0.45	0.90
		226M1	50/30	D	400	200	0.5	1.5	—	80	7	—	0.70	1.25
>8		269M1	50/30	D	480	240	0.5	1.75	55	—	7	0.8	—	1.5
		225M1	50/30	D	250	125	0.5	3.0	—	35	3	—	1.15	2.4
		222M2	80/50	E	400	200	0.5	3.0	—	75	10	—	1.15	2.3

The types shown in this chart represent a selection of the most recently announced RCA Cores intended for Coincident-Current Applications. The data shown for these types have been selected at the time of publication, to cover the operating capabilities believed to be of

greatest interest to equipment manufacturers. For information on other RCA Cores for Coincident-Current Applications, please contact your RCA Sales Office shown on the back cover of this publication.



RCA FERRITE MEMORY CORES

IMPULSE-SWITCHING (LINEAR-SELECT) TYPES

System Cycle Time (Linear Select)	Recommended RCA Type	Dimensions		Recommended Driving Current Pulse				Typical Performance Characteristics at 25° C			
		Size OD/ID	Outline Page 8	Pulse	Current	Rise Time t_r	Duration t_d	"Undisturbed-1" Output Voltage μV_1	"Disturbed-0" Output Voltage dV_z	μV_1 Peaking Time t_p	Total Switching Time t_s
		mils			ma	μsec	μsec	mv	mv	μsec	μsec
less than 1	400M1	30/18	C	Read I_R	380	0.10	0.12	50	8	0.10	0.20
				Full I_{FW}	280	0.08	0.16				
				Write Impulse I_{IW}	180	0.08	0.16				
				Digit I_{DW}	100	0.15	0.25				
	401M1	50/30	D	Read I_R	570	0.10	0.30	120	18	0.11	0.19
				Full I_{FW}	225	0.10	0.60				
				Write Impulse I_{IW}	130	0.10	0.60				
				Digit I_{DW}	125	0.10	0.60				
1 to 2	404M1	30/18	C	Read I_R	400	0.10	0.40	85	10	0.13	0.23
				Full I_{FW}	290	0.08	0.19				
				Write Impulse I_{IW}	190	0.08	0.19				
				Digit I_{DW}	100	0.22	0.38				

RCA TRANSFLUXORS

RCA Transfluxors are intended for use in Magnetic-Memory Applications – to provide continuous non-destructive readout of stored information at any desired level up to its maximum output capa-

bility; and in Channel Selector Applications – to control transmission of ac signals from a common channel to any one of several channels, or from any one of several channels to a common channel.

FOR WIDE-TEMPERATURE RANGE, HIGH-SPEED, LINEAR-SELECT APPLICATIONS

Type	Dimensional Outline See Page 8	Block Current I_b	Driving Current Pulse					Typical Performance Characteristics at 25° C			
			Set Current I_s	Full-Read Current I_m	Prime Current I_p	Rise Time t_r	Duration t_d	"Undisturbed 1" Output Voltage μV_1	"Disturbed 0" Output Voltage dV_z	μV_1 Peaking Time t_p	Switching Time t_s
			ma	ma	ma	μsec	μsec	mv	mv	μsec	μsec
0154M5	F	1000	600	600	350	0.1	2.0	170	25	0.13	0.3
0163M5	G	1000	500	400	400	0.5	2.0	35	7	0.8	1.4



RCA MEMORY PRODUCTS

RCA MEMORY PLANES

RCA Memory Planes utilizing wide-temperature range ferrite cores or conventional ferrite cores and intended for coincident-current, word-address, or impulse-switching operation are available from stock. RCA Memory Planes can also be custom designed to meet exacting equipment requirements.

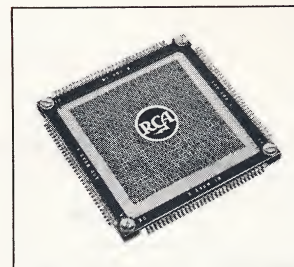


Fig.2 - Typical Ferrite Core Memory Plane.

MEMORY PLANES WITH WIDE-TEMPERATURE RANGE CORES

Type	Outline Page 9	Core Complement		Driving Current Pulse Characteristics					Typical Performance Characteristics at T _{FA} (°C) as Indicated														
				Write (I _W /2), Read (I _R /2), and Inhibit (I _I) Values for the Following Characteristics are Identical Except as Specified					“Double-Checkerboard” (Worst-Noise-Case) Input Pattern. Sense Winding Termination Impedance = 200 ± 2 ohms														
		Type	Array	Amplitude Per Winding ma	Duration t _d μsec	Fall Time t _r μsec	Rise Time t _f μsec	Source Impedance R _g ohms	“Dis- turbed-1” Output Voltage dV ₁ (mv)			Zero “Δ” Noise Output Voltage V _Δ (mv)						“ONE” Peaking Time t _{p1} (μsec)			“ONE” Switching Time t _{s1} (μsec)		
												-25	+25	+75	-25	+25	+75	-25	+25	+75	-25	+25	+75
N7190-1	H	233M1	4096 (64 × 64)	400	4	0.5	0.5	200 ± 2	54	56	58	9	12	14	3	3	4	0.98	0.94	0.95	1.44	1.40	1.50
N7166-1	H	233M1	1024 (32 × 32)	400	4	0.5	0.5	200 ± 2	60	64	64	6	9	11	2	2	2	0.89	0.88	0.87	1.34	1.38	1.40
NA2127	I	269M1	1024 (32 × 32)	240 210 for I _I	2 2.2 for I _I	0.4	0.4	200 ± 2	40	48	48	10	10	10	4	4	4	0.80	0.80	0.78	1.60	1.60	1.60
NA2142	I	270M1	1024 (32 × 32)	400	0.5 0.6 for I _I	0.1	0.1	200 ± 2	58	64	70	21	25	26	5	5	5	0.22	0.23	0.25	0.55	0.54	0.51

MEMORY PLANES WITH CONVENTIONAL CORES

Type	Outline Page 9	Core Complement		Driving Current Pulse Characteristics					Typical Performance Characteristics at T _{FA} = 25° C				
				Write (I _W /2), Read (I _R /2), and Inhibit (I _I) values for the Following Characteristics are Identical Except as Specified					"Double-Checkerboard" (Worst-Noise-Case) Input Pattern. Sense Winding Terminating Impedance = 200 ± 2 ohms				
		Type	Array	Amplitude Per Winding	Duration t _d	Fall Time t _r	Rise Time t _f	Source Impedance R _g	"Disturbed-1" Output Voltage dV ₁	Zero "Δ" Noise Outline Voltage V _Δ		"ONE" Peaking Time t _{p1}	"ONE" Switching Time t _{s1}
										Max.	at dV ₁		
N7165-1	H	230M1	1024 (32 × 32)	220 210 for I _I	1.2 2 for I _I	0.2	0.2	200 ± 2	64	8	2	0.68	1.20
NA2141	I	0150M5	1024 (32 × 32)	275	0.5 0.7 for I _I	0.15	0.15	200 ± 2	70	26	5	0.29	0.50



RCA MONOLITHIC FERRITE MEMORY MODULE

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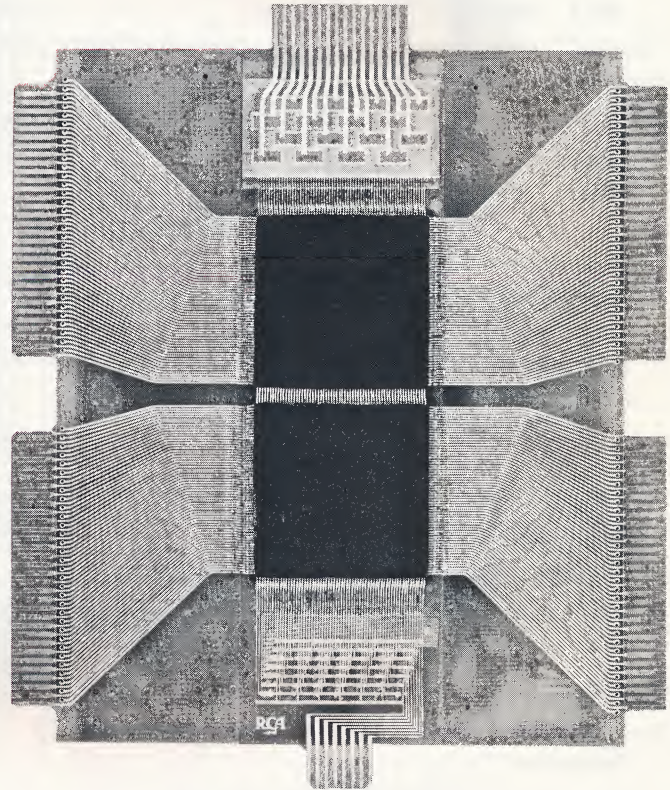


Fig.3 - RCA MF2100 contains the basic module 4-1/2" x 1.2", complete with integrated diode matrix and 2 wafers.

- High switching speed: $t_s = 35$ nanoseconds typical
- High output voltages: dV_{O-} or $dV_{I+} = 30$ to 45 mv typical
- Bipolar output voltages
- Low driving currents: $I_W = 100$ to 150 ma
 $I_R = 400$ ma $I_D = 30$ ma
- Complete with interconnected integrated silicon-diode selection matrix
- Small Size (Including external circuit terminals) — 4.5" x 3.75" x .22" thick

Driving Current Pulse Characteristics									Typical Performance Characteristics at 25° C (Sense-Winding Terminating Impedance = 150 ohms)		
Read			Write			Digit			dV_{O-} or dV_{I+}	t_s of dV_{O-} or dV_{I+} (10% points)	Read Driving Voltage
I_R	t_r & t_f	t_d (50% points)	I_W	t_r & t_f	t_d (50% points)	I_D	t_r & t_f	t_d (50% points)			
ma	nsec	nsec	ma	nsec	nsec	ma	nsec	nsec	mv	nsec	mv/bit
400	45	110	100	45	120	30	45	200	35	60	250
400	30	80	120	30	100	30	30	200	45	35	300
400	30	60	150	30	30	30	30	100	30	35	320

For Dimensional Outline, See Page 8.



RCA MEMORY PRODUCTS

RCA MEMORY SYSTEMS

RCA MS-Series Memory Systems utilize modular "plug-in" components to provide great flexibility in the choice of capacity, speed, and operating mode.

STORAGE CAPABILITY – RCA MS-Series Systems can be supplied with storage capacities of from 512 to 32768 words – 36 to 72 bits per word.

QUALITY & RELIABILITY – RCA MS-Series Systems are designed to meet military specifications MIL-E-5148 and MIL-Q-9858, and NASA specification MSFC-PROC-18B. These Memory Systems can also be designed to meet other applicable specifications, and can be inspected to NPC200-2, if required.

STANDARD FEATURES

- Plug-In Stack Assembly and Diode Matrix
- Designed-In Reliability Through Conservative Design Criteria
- Information Retention and Under-Over Voltage Protection In Power Supply
- 5 Operating Modes: R/R, C/W, R/O, W/O, R/M/W
- System Designed For Both Word and Bit Length Expansion
- Rugged Mechanical Construction Combined With Accessibility Of All Components

OPTIONAL FEATURES – RCA MS-Series Systems can be supplied with these optional features to provide greater systems versatility:

- Sequential Register
- Interlace Register
- Forward-Backward Counter
- Self-Testing Circuits
- Parity Checking Circuits
- Interfacing Circuits
- Indicator Lights
- Special Mechanical Design and Finishes

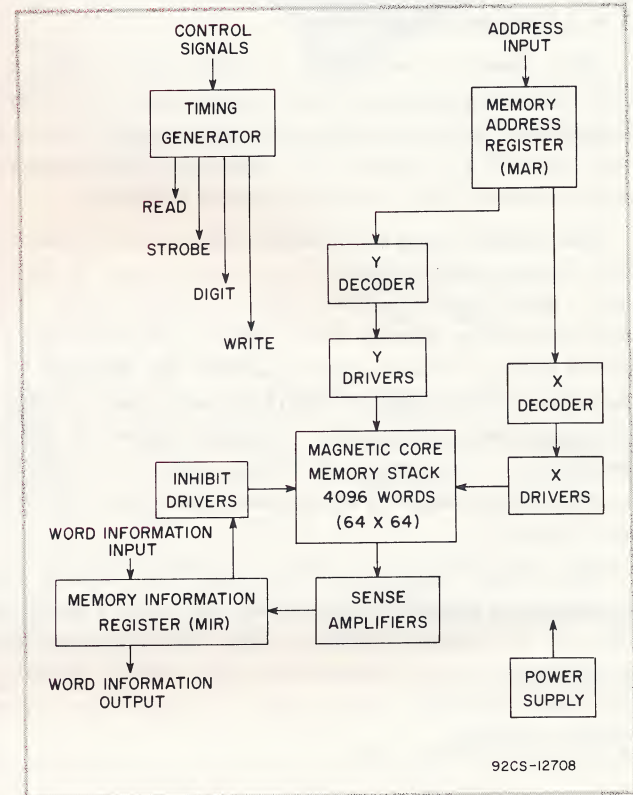


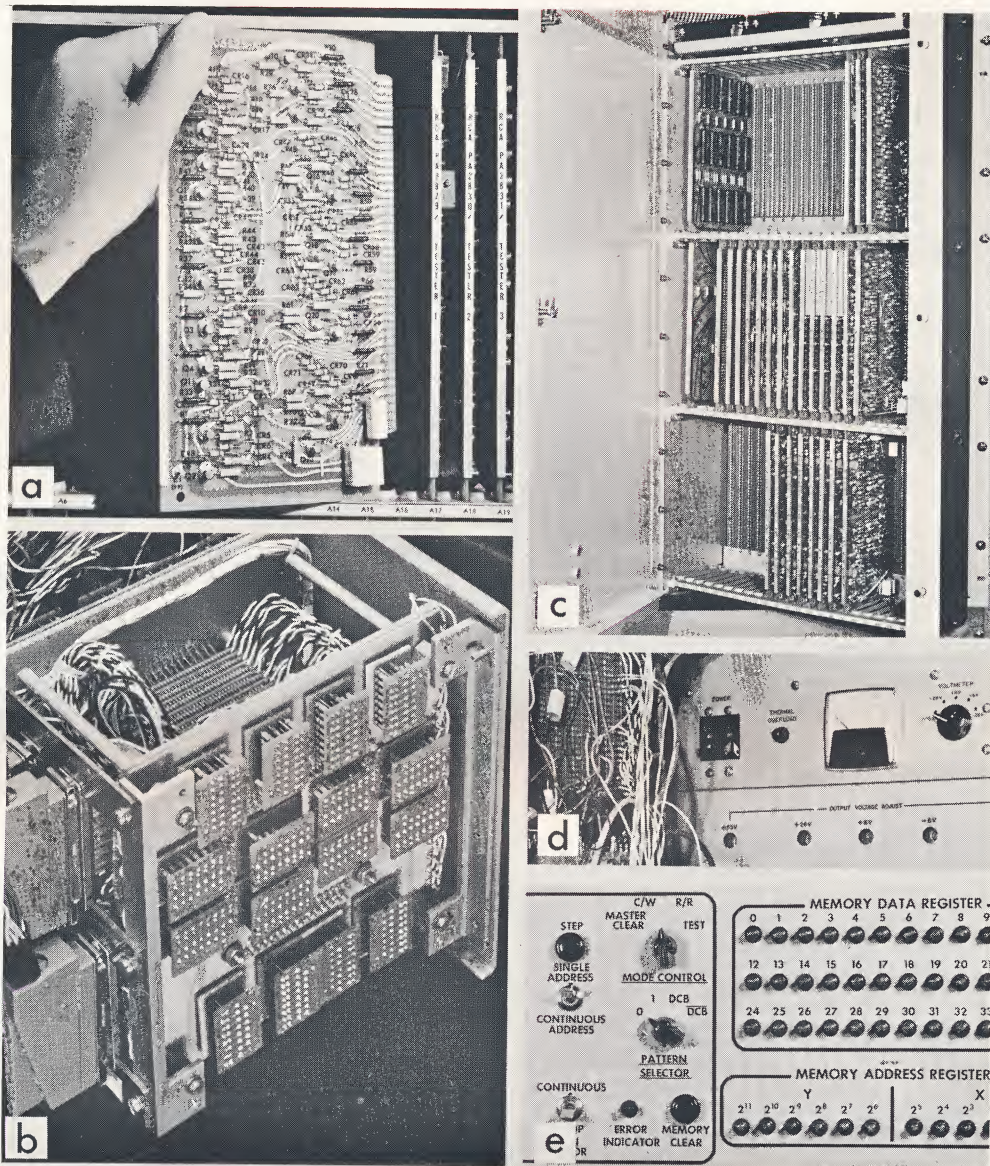
Fig.4 - Block diagram of typical 4096-word coincident-current memory system.

RCA MS-SERIES HIGH-SPEED MEMORY SYSTEMS

MS-Series System	System Cycle Time (μsec)	Access Time μsec	Maximum Capacity		Transistor and Diode Complement	Operating Temperature Ranges – °C			
						Using Conventional Cores			Using Wide Temperature Range Cores
						Without Current Compensation	With Current Compensation		
			Words	Bits Per Word			Read/Write	Read/Write and Digit	
MS-1	1.0	0.4	32768	72	Silicon	15 to 35	10 to 40	0 to 50	-40 to +80
MS-2	1.5	0.6	32768	72	Silicon	15 to 35	10 to 40	0 to 50	-40 to +80
MS-5	3.5	1.5	33768	72	Germanium and Silicon	15 to 35	10 to 40	0 to 50	—



RCA MS-1 HIGH-SPEED MEMORY SYSTEM



- a) Highly Efficient Circuit Board Designs – Vertical Installation Permits 86 Connections Per Board; Shorter Current Path
- b) Easy Access To Memory Stack
- c) Easy Access To Printed Circuit Boards

- d) Easy Access To Power Supply
- e) Self Testing – RCA MS-1 Memory Systems Can Be Supplied With Built-In Tester To Locate Read-In and Read-Out Errors

Fig.5 - RCA MS-1 Coincident-Current Memory System.

RCA MEMORY STACKS

RCA Memory Stacks incorporating RCA Memory Planes can be custom designed with wide temperature-range capabilities, or temperature control, as well as high-density packaging features to meet exacting equipment requirements.



Fig.6 - Aerospace Memory Stack
16,384 Bit Storage Capacity.

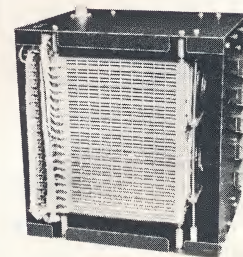
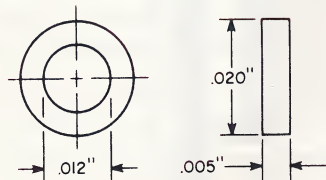


Fig.7 - Commercial Memory Stack
280,000 bit Storage Capacity.

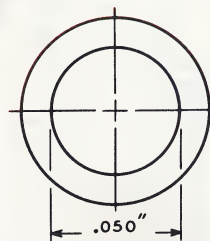


RCA MEMORY PRODUCTS

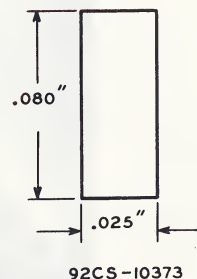
DIMENSIONAL OUTLINES



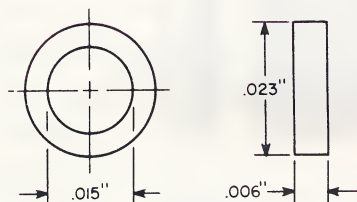
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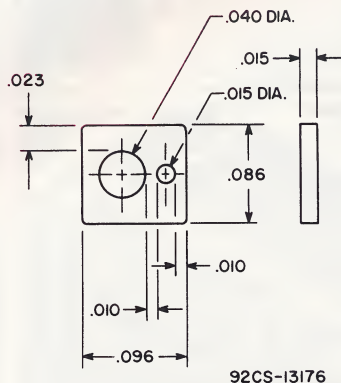
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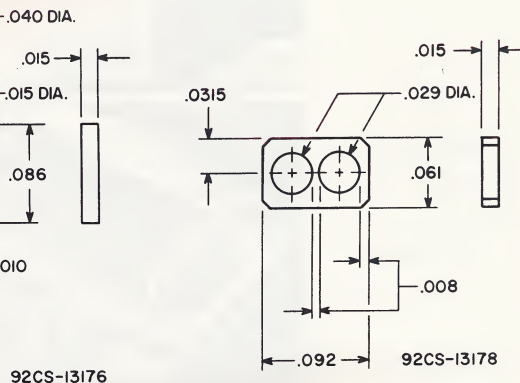
92CS-10373



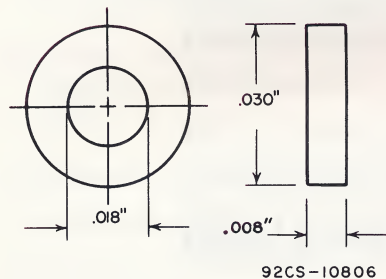
B
0175M5



F
0154M5

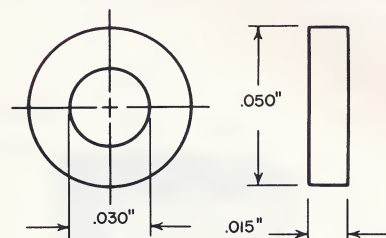


G
0163M5



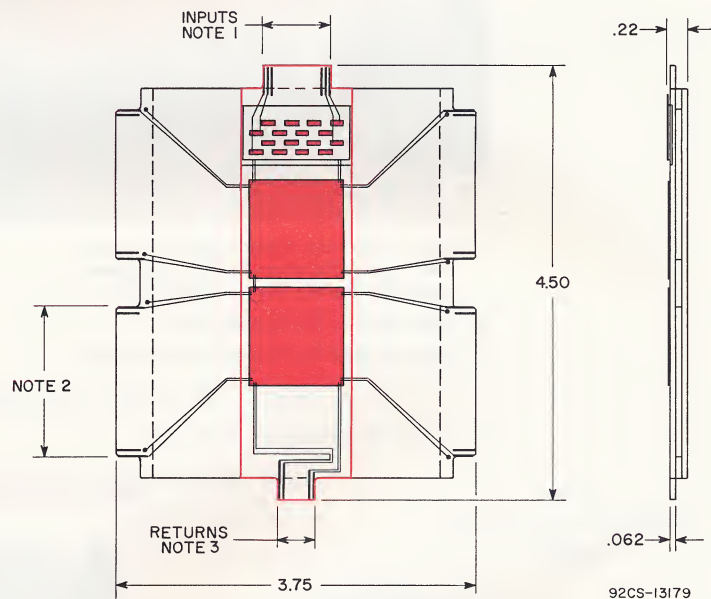
C
0167M5 0183M5
0172M5 270M1
0173M5
400M1
404M1

92CS-10806



D
222M1 264M1
225M1 269M1
226M1 232M1
401M1

92CS-11237



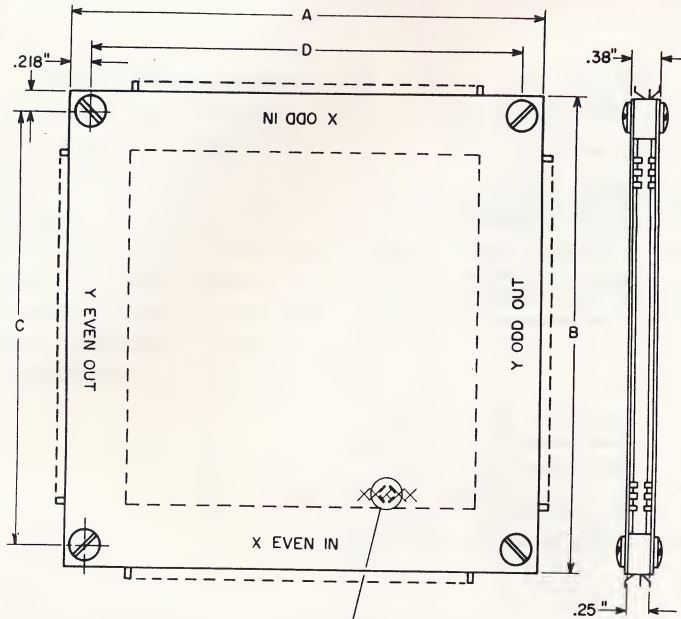
92CS-13179

Note 1: 16 Single-Sided Connections on 0.050 "Centers.
Note 2: 32 Double-Sided Connections on 0.050 "Centers.
Note 3: 8 Single-Sided Connections on 0.050 "Centers.

MF2100

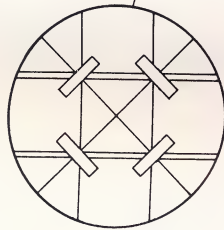


DIMENSIONAL OUTLINES



H

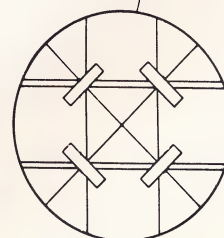
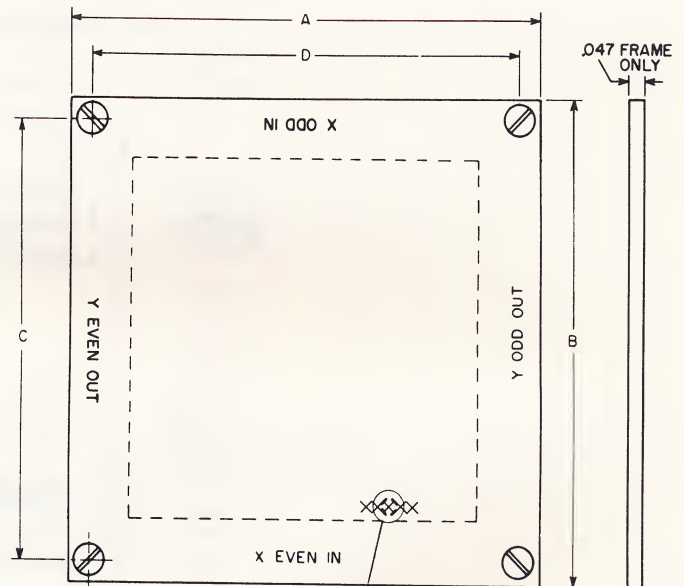
DIMENSION	RCA TYPE		DIMENSION	RCA TYPE	
	N7165-1	N7097-1		N7165-1	N7097-1
A	3.1"	5.1"	C	2.697"	4.625"
B	3.1"	5.1"	D	2.697"	4.625"



92CS-11871

I

DIMENSION	RCA TYPE		DIMENSION	RCA TYPE	
	NA-2141			NA-2141	
A	2.1"		C	1.88"	
B	2.1"		D	1.88"	

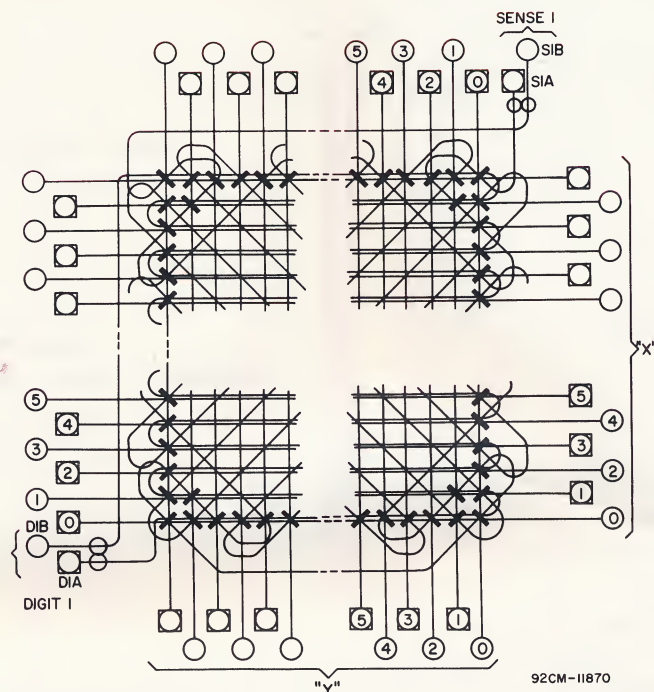


92CS-13177



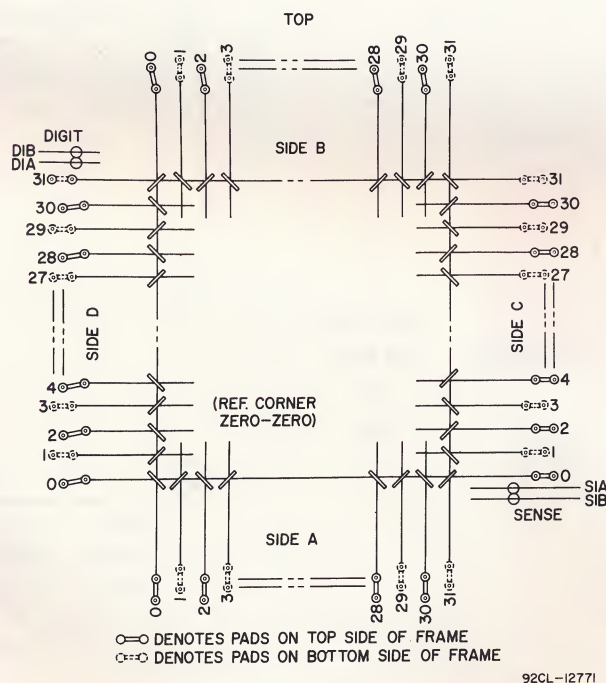
RCA MEMORY PRODUCTS

WIRING DIAGRAMS FOR RCA MEMORY PLANES



○ DENOTES TERMINALS ON TOP SIDE OF FRAME.
 ○ DENOTES TERMINALS ON BOTTOM SIDE OF FRAME.
 — DENOTES TWISTED PAIR.

Fig. 8 - Typical Wiring Diagram for RCA Types N7165-1, N7190-1, N7166-1 Memory Planes Utilizing Wide-Temperature Range Cores.



○ DENOTES PADS ON TOP SIDE OF FRAME
 ○ DENOTES PADS ON BOTTOM SIDE OF FRAME

Fig. 9 - Typical Wiring Diagram for RCA Types NA2141, NA2142, and NA2127 Memory Planes Utilizing Conventional Cores.



RCA TRANSISTORS FOR COMPUTER APPLICATIONS

RCA's comprehensive line of transistors for data-processing and computer applications includes silicon n-p-n types, germanium p-n-p types, and germanium n-p-n types in hermetically sealed JEDEC industry standard packages for low-current logic, high-current logic, and core and memory driver applications. The RCA line of computer transistors also includes general-purpose switching types, types with characteristics which make them extremely useful in a variety of applications in data-processing equipment, ultra high-reliability types,

and types meeting Military and Aerospace Specifications. RCA can also provide custom transistors and other semiconductor devices to meet your specific application requirements.

The chart below gives application data for these devices. Complete technical data for any of these transistors may be obtained from the RCA Sales Offices shown on the back cover, or from RCA Electronic Components and Devices, Commercial Engineering, Harrison, N.J., 07029.

Core-Driver Types

Silicon NPN

2N2476	2N3261	2N3512	40283
2N2477	2N3262		

Switching Types

High-Voltage

Germanium PNP

2N398	2N398A	2N398B	2N586
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Medium-Speed

Germanium PNP

2N395	2N404A	2N1301	2N1384
2N396	2N414	2N1303	2N1683
2N396A	2N581	2N1305	2N1853
2N397	2N582	2N1307	2N1854
2N404	2N1300	2N1309	

Germanium NPN

2N388	2N1090	2N1304	2N1605
2N388A	2N1091	2N1306	2N1605A
2N585	2N1302	2N1308	

High-Speed

Silicon NPN

2N706	2N709	2N1708	2N2475
2N706A	2N834	2N2205	2N2938
2N708	2N914	2N2206	2N3261

40217 (2N706 in TO-52 pkg.)

40218 (2N706A in TO-52 pkg.)

40219 (2N708 in TO-52 pkg.)

40220 (2N834 in TO-52 pkg.)

40221 (2N914 in TO-52 pkg.)

40222 (2N2205 in TO-52 pkg.)

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For further information on **RCA Memory Products** and their applications, contact:

RCA MEMORY PRODUCTS, NEEDHAM HEIGHTS, MASS.

or your nearest RCA Sales Office:

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Mid-Atlantic:	Haddonfield	605 Marlton Pike, Haddonfield, N.J. 08034	(609) 428-4802
	Orlando	200 East Marks St., Orlando, Fla. 32803	(305) 425-5563
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	Detroit	714 New Center Building, Detroit, Mich. 48202	(313) 875-5600
	Minneapolis	5805 Excelsior Boulevard, Minneapolis, Minn. 55416	(612) 929-0676
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West:	Hollywood	6363 Sunset Boulevard, Hollywood, Calif. 90028	(213) 461-9171
	Los Altos	4546 El Camino Real, Suite P, Los Altos, Calif. 94022	(415) 948-8996
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